

## Elastomeric Dampers derived from First-Principles-Based Analytical Simulation

### Materials Technologies Corporation

#### Technical Abstract

Lead-lag motions of rotor blades in helicopters require damping to stabilize them. In practice, this has necessitated the use of external hydraulic dampers which suffer from high maintenance costs. High operational (lifecycle) cost has prompted rotorcraft industry to use elastomeric lead-lag dampers that result in “dry” rotors. However, complex behavior of elastomers provides challenges for modeling such devices, as noted by rotorcraft airframers. Currently used analytical models oversimplify the complexity of operational environment and make radical assumptions about operating parameters that, at best, lead to excessively simplistic, and often unreal, device models. These first order linear device models require costly and time consuming experiments to construct them; moreover, they do not directly relate to either the material characteristics or the geometric configuration. In Phase-I SBIR, MTC team pursued a fundamentally radical approach wherein elastomeric dampers are derived from first-principle-based modeling rather than device model-based analyses. Our Phase-I program was tailored towards successfully demonstrating closed loop simulation, i.e. a finite element based modeling of elastomeric materials integrated into a multibody dynamics framework for rotorcraft analysis. During Phase-II, comprehensive and sophisticated material models will be implemented and streamlined into a single comprehensive analysis framework. These implementations will be fully validated against bench and flight test data of Bell M429 elastomeric dampers. These program objectives will be accomplished via collaborative tripartite partnership with Bell Helicopter and Georgia Tech.

#### Company Contact

Yogesh Mehrotra  
(203) 874-3100  
ymehrotra@aboutmtc.com

## Computational Wind Tunnel: A Design Tool for Rotorcraft

### Sukra Helitek, Inc.

#### Technical Abstract

During initial design studies, parametric variation of vehicle geometry is routine. In addition, rotorcraft engineers traditionally use the wind tunnel to evaluate and finalize designs. Estimation of rotor tunnel blockage is significantly more complex than bluff body corrections as the correction depends on operational characteristics such as rotor RPM and thrust produced. This proposal offers to develop an Integrated Design Environment (IDE) which can simulate a complete rotorcraft with or without wind tunnel walls including all the facility effects. At the heart of the innovation are: 1. An automated hybrid grid generator (viscous grids near the bodies and unstructured Cartesian grid everywhere else). 2. A robust and economical incompressible flow solver for the entire system of grids. 3. Momentum source based rotor model that is suitable and economical for simulating configurations with multiple rotors. In Phase I, the proof-of-concept developed used unstructured Cartesian grid for the model and wind tunnel. In phase II, the tool will be extended to hybrid grid with viscous grid near solid surfaces and will include several tools including a simple CAD like geometry manipulation tool and pre- and post-processing tools all integrated in one environment to facilitate ease of use.

#### Company Contact

Angela Lestari  
(515) 292-9646  
nappi@sukra-helitek.com